CERTIFICATION OF TRANSLATION

I, ***Hye-young Jang***, an employee of Y.P.LEE, MOCK & PARTNERS of Koryo Bldg., 1575-1 Seocho-dong, Seocho-gu, Seoul, Republic of Korea, hereby declare under penalty of perjury that I understand the Korean language and the English language; that I am fully capable of translating from Korean to English and vice versa; and that, to the best of my knowledge and belief, the statement in the English language in the attached translation of ***Korean Patent Application No. 10-2002-0059139*** consisting of 14 pages, have the same meanings as the statements in the Korean language in the original document, a copy of which I have examined.

Signed this 28th day of June 2006

Hye-young Jang

ABSTRACT

[Abstract of the Disclosure]

Provided is a high density optical disk with a super resolution near field structure. The optical disk has large storage capacity and high density of recorded data. Accordingly, there is no need to decrease the wavelength of a laser diode or increase the numerical aperture in an objective lens. In addition, because a source of the surface plasmon is fine metal particles not a silver oxide, a laser with a high reading power is not required. For this reason, the recording state of a recording layer is stable. Furthermore, because dissociation and association of silver oxide are not required, although a recording and reading procedure is repeated, stability of the optical disk is secured.

[Representative Drawing]

FIG. 1

[Keywords]

Super resolution near field structure

SPECIFICATION

[Title of the Invention]

High Density Optical Disk

[Brief Description of the Drawings]

FIG. 1 is a schematic view of an optical disk of the present invention.

FIG. 2 is a schematic view of an optical disk with a conventional structure.

FIG. 3 is a schematic view of an optical disk with the structure as defined in Example 2 of the present invention.

<Description of reference numerals for main components of Drawings>

10: substrate	11: mask layer
12: recording layer	13: reflective layer
14: dielectric layer	15: mark
16: silver particle	

[Detailed Description of the Invention]

[Object of the Invention]

[Technical Field of the Invention and Related Art prior to the Invention]

The present invention relates to a high density optical disk, and more particularly, to a high density optical disk, readable only or recordable and readable, having a super resolution near field structure, on which marks with a size smaller than the resolution of a laser beam can be recorded.

Because optical disks have very small recording area per recording unit in comparison with existing magnetic recording media, they are widely used as high density recording media. According to their characteristics, optical disks are classified into a Read Only Memory (ROM) type, a Write Once Read Many (WORM) type, and an erasable type. The ROM type of optical disks can only read pre-recorded data, the WORM type of optical disks allows a user to write data onto a disk only once, and the erasable type of optical disks allows a user to erase and re-record data.

One example of the WORM optical disks is a compact disk recordable (CD-R) disk. In a CD-R disk, when a recording laser beam with a wavelength of 780 nm is

focused on a recording layer made from an organic dye material such as cyanine and phthalocyanine, bonds in the organic dye material are broken. At the same time, the structures of a substrate and a reflecting layer are optically changed. Under this process, data are recorded on a CD-R disk. The recorded data are read with a low power of 1 mW or less. A CD-R disk has a storage capacity of about 650 MB and thus is widely used for recording and reading various types of data such as audio and video.

However, the storage capacity of optical recording media which require a recording wavelength of 780 nm is insufficient to record dynamic image data. Therefore, such optical recording media with a small storage capacity are impractical in today's complex multimedia environment.

In order to solve this problem, Digital Versatile Disks (DVDs) which require a shorter laser wavelength of 630-680 nm have been developed. The DVDs have a storage capacity of 2.7 to 4.7 GB (on one side). Generally, DVDs can be classified into a DVD-read only memory (DVD-ROM) type, a DVD-recordable (DVD-R) type, a DVD-random access memory (DVD-RAM) type, and a DVD-rewritable (DVD-RW) type. Recording on the DVD-R disks is accomplished through the use of a recording layer in which bonds in an organic dye material are broken upon exposure to a recording laser beam. The DVD-RAM and the DVD-RW disks use a phase change method to record or erase data. The recording layer's phase change alters the optical characteristics of disks. As a result, data are recorded on or erased from disks. In particular, the DVD-R disks using an organic dye material are compatible with DVD-ROM, cost effective, and have a large storage capacity in comparison with other recording media. For these reasons, much attention has been paid to the DVD-R disks at present.

As can be seen from the above description, the most important issue in a one-time recordable or re-recordable optical recording media is now to increase the storage capacity. In this regard, various attempts have been made to increase the storage capacity. The storage capacity of optical disks depends on the number of pits and the wavelength of a laser beam used to read the pits. That is, as the number of pits on a predetermined surface of optical disks is increased or the wavelength of a

laser beam is decreased, the storage capacity of optical disks is increased. Generally, a cross section of a laser beam emitted from a laser diode spreads due to diffraction through the laser's exit aperture in spite of using an objective lens. This beam size is called "diffraction limit". General optical disks have a reading resolution limit, i.e. a beam size, given by the expression: $\lambda/4NA$, where λ is the wavelength of a laser and NA is the numerical aperture in an objective lens. As can be seen from the above expression, the storage capacity of optical disks can be increased by reducing the beam size, i.e., by shortening the laser beam's wavelength or using an objective lens with a larger NA. However, there are limitations in that recent laser technologies cannot provide such a shorter wavelength laser and an objective lens with lager NA is expensive. Furthermore, as NA in an objective lens is increased, a distance (working distance) between a pickup and a disk is remarkably shortened and the pickup and the disk might collide with each other. As a result, damages to the surface of the disk may be caused, resulting in data loss.

In order to overcome the aforementioned reading resolution limit, optical disks having a super resolution near field structure (hereinafter simply referred to as "super-RENS") have been studied. In optical disks having such a super-RENS, a silver oxide film is mainly used as a mask layer. FIG. 2 schematically shows an optical disk with a silver oxide mask layer. When such a structure is exposed to a laser beam having a power higher than a conventional reading power, the silver oxide is dissociated into silver particles and oxygen. As a result, plasmons are formed on the surfaces of the silver particles. Such surface plasmons induce near field recording (NFR). Furthermore, very small marks beyond the diffraction limit can be read from optical disks having such a super-RENS. However, in such super-RENS disks using silver oxide, a temperature (about 160℃) for dissociating the silver oxide into silver particles and oxygen is almost similar to that (about 150℃) for crystallizing a phase change recording layer. This may cause loss of recorded data. That is, when a high power laser beam is focused on a mask layer to dissociate the silver oxide into silver particles and oxygen, an amorphous recording layer is crystallized. As a result, recorded data

may be erased. In addition, when recording and reading of data are repeated, changes in a mask layer, i.e., dissociation of silver oxide into silver and oxygen and association of silver and oxygen into silver oxide may be incompletely reversed. In particular, in a case where the dissociated silver and oxygen are not uniformly distributed, recording data may incorrectly read. In this regard, silver metal instead of silver oxide can be considered. However, a mask layer made of silver metal absorbs a large amount of a laser beam. As a result, a sufficient light efficiency cannot be obtained and finer recording marks cannot be read.

[Technical Goal of the Invention]

The present invention provides an optical disk with large storage capacity, high density, and good storage stability of recorded data. Accordingly, there are no needs to decrease the wavelength of a laser diode or increase the numerical aperture in an objective lens.

[Structure and Operation of the Invention]

According to an aspect of the present invention, there is provided a high density optical disk, readable only or recordable and readable, comprising a plastic substrate; one or more mask layers with a super resolution near field structure; and a reflective layer. The mask layers are made of a mixture of a dielectric material and metal particles. When the optical disk is used as a readable only disk, a pit pattern is formed on the substrate, and when the optical disk is used as a recordable and readable disk, the optical disk further comprises a recording layer.

According to specific embodiments of the present invention, the dielectric material is metal oxide, nitride, sulfide, fluoride or a mixture thereof.

Preferably, the dielectric material is ZnS-SiO_2.

The metal particles are derived from gold, silver, platinum, rodium, palladium or a mixture thereof.

Preferably, the metal particles are silver particles.

The optical disk further comprises dielectric layers on the upper and the lower surfaces of the mask layer.

Hereinafter, the present invention will be described in more detail with reference to the accompanying drawings.

In FIG. 1, an optical disk of the present invention comprises a transparent substrate 10, a mask layer 11, a recording layer 12, and a reflective layer 13.

The substrate 10 is very transparent to a wavelength of a recording laser. The substrate is formed by a conventional substrate manufacturing method such as injection molding using a material with excellent impact resistance, heat resistance, and weatherability. Examples of the substrate material include polycarbonate, polymethylmethacrylate, epoxy, polyester, and amorphous polyolefin.

The recording layer 12 is made of a material to be phase changed upon exposure to a recording laser beam. The material for the recording layer includes Ge-Sb-Te and Ag-In-Sb-Te. A laser beam spot induces the formation of amorphous recording marks when data are recorded.

The reflective layer 13 is used to secure high reflectivity when data are recorded or read. In this regard, it is preferable to use a metal with high heat conductivity and reflectivity as the material for the reflective layer. Examples of the reflective layer material include Au, Al, Cu, Cr, Ag, Ti, Pd, Ni, Zn, Mg and an alloy thereof. The reflective layer is formed to have a thickness of 50 to 150 nm by means of vacuum deposition, electronic beam, or sputtering. It is preferable to use a reflective layer with a thickness of 60 to 120 nm to secure a sufficient reflectivity and reliability.

The mask layer 11 of the present invention is formed using a mixture instead of using a conventional silver oxide. The mixture is formed of fine metal particles that are dispersed in a dielectric material. The size of the fine metal particles is smaller than that of a laser beam. The mask layer acts as an aperture for a near field light due to self-focusing effect. Therefore, fine marks with a size of 100 nm or less can be recorded on the recording layer using a laser wavelength of 680 nm. According to the present invention, a source of a surface plasmon is the fine metal particles such as fine silver particles. For this reason, a process for separating silver oxide into fine silver particles and oxygen using a high power laser like in a conventional method is not

required. Therefore, when data are read, the recording state of the recording layer is not affected. The dielectric material to be used in the masking layer is metal oxide, nitride, sulfide, fluoride or a mixture thereof. For example, SiO_2, Al_2O_3, Si_3N_4, SiN, ZnS or MgF_2 can be used. The preferred metal particles to be dispersed in the masking layer are derived from a noble metal such as gold, silver, platinum, rodium and palladium. In this case, because the dielectric material and the metal particles are not chemically reacted with each other, the original shape of the fine metal particles can be maintained. The mask layer may be positioned between the substrate and the recording layer or at both surfaces of the recording layer. The mask layer is deposited by a sputtering process. The target of the sputtering process is a mixture of the dielectric material and the fine metal particles. Therefore, the fine metal particles with a size smaller than a laser beam can be dispersed in the dielectric material using the sputtering process.

The mask layer of the present invention may be used in a re-recordable disk, a one-time recordable disk, and a readable only disk. In addition, the mask layer may be used in a single-sided, dual-layered disk, a double-sided, single-layered disk, or a double-sided, dual-layered disk.

With reference to a readable only disk, because pits are formed on a substrate, no recording layers are required.

Although not shown in FIG.1, the optical disk of the present invention may further comprise a protective layer. The protective layer acts to protect other layers, in particular the reflective layer 12. The protective layer can be formed using a conventional method such as spin coating. In detail, an epoxy- or acrylate- based ultraviolet light curable resin is spin coated on the reflective layer 12, followed by ultraviolet light curing to thereby form the protective layer. The epoxy- or acrylate-based ultraviolet light curable resin is required to be transparent, exhibit a high impact strength, and be curable using an ultraviolet light.

The mask layer 11 also acts as a dielectric layer because of the presence of the dielectric material. However, the optical disk of the present invention may further

comprise separate dielectric layers at the upper and the lower surfaces of the mask layer 11. A first dielectric layer between the mask layer 11 and the substrate 10 acts to prevent deformation of the substrate and heat diffusion toward the mask layer. On the other hand, a second dielectric layer between the mask layer 11 and the recording layer 12 acts to prevent deterioration of the mask layer caused by a high temperature involved when data are repeatedly recorded. FIG. 3 shows an optical disk with separate dielectric layers. Such separate dielectric layers result in a higher carrier to noise ratio (C/N) value.

Hereinafter, the present invention will be described in more detail with reference to Examples but is not limited thereto.

Example 1

A polycarbonate (PC) substrate with a thickness of 0.6 mm was prepared. The substrate had a pre-groove structure with track pitch of 0.40 ㎛. A $ZnS\text{-}SiO_2$+Ag mask layer and a Ge-Sb-Te recording layer were successively deposited on the substrate using a sputtering process. Then, an Ag reflective layer with a thickness of 100 nm was deposited on the recording layer using a sputtering process and then a light curable resin based protective layer was spin coated on the reflective layer. The layers were then dried in a vacuum oven at 40℃ for 12 hours to prepare an optical disk. In this case, the mask layer was formed by means of a sputtering process after forming a mixture of $ZnS\text{-}SiO_2$ and Ag as a target.

Example 2

A polycarbonate (PC) substrate with a thickness of 0.6 mm was prepared. The substrate had a pre-groove structure with track pitch of 0.40 ㎛. A $ZnS\text{-}SiO_2$ dielectric layer, a $ZnS\text{-}SiO_2$+Ag mask layer, a $ZnS\text{-}SiO_2$ dielectric layer, a Ge-Sb-Te recording layer, a $ZnS\text{-}SiO_2$ dielectric layer, and an Ag reflective layer were successively deposited on the substrate. Then, a light curable resin based protective layer was spin coated on the reflective layer. The layers were then dried in a vacuum oven at 40℃ for 12 hours to prepare an optical disk. In this case, the mask layer was formed by means of a sputtering process after forming a mixture of $ZnS\text{-}SiO_2$ and Ag as a target.

Comparative example 1

A polycarbonate (PC) substrate with a thickness of 0.6 mm was prepared. The substrate had a pre-groove structure with track pitch of 0.40 μm. A ZnS-SiO_2 dielectric layer, an AgOx mask layer, a ZnS-SiO_2 dielectric layer, a Ge-Sb-Te recording layer, a ZnS-SiO_2 dielectric layer, and an Ag reflective layer were successively deposited on the substrate. Then, a light curable resin based protective layer was spin coated on the reflective layer. As a result, an optical disk with a silver oxide mask layer was formed.

Comparative example 2

A polycarbonate (PC) substrate with a thickness of 0.6 mm was prepared. The substrate had a pre-groove structure with track pitch of 0.40 μm. A ZnS-SiO_2 dielectric layer, a Ge-Sb-Te recording layer, a ZnS-SiO_2 dielectric layer, and an Ag reflective layer were successively deposited on the substrate. Then, a light curable resin based protective layer was spin coated on the reflective layer. As a result, an optical disk without a mask layer was formed.

Experimental Example

Properties of each disk of Examples 1 and 2 and Comparative examples 1 and 2 were measured using a laser with a beam wavelength of 405 nm and a pickup of a numerical aperture of 0.65. The reading resolution limit (λ/4NA) was 156 nm. A 200 nm mark larger than the reading resolution limit and a 120 nm mark smaller than the reading resolution limit were recorded and the carrier to noise ratio (C/N) value was measured. With respect to the C/N value, in order to evaluate stability upon reading of data signals, the C/N value was measured after data signals were read for 10 minutes. The results are presented in Table 1 below.

Table 1

Section	Example 1	Example 2	Comparative example 1	Comparative example 2
Reading power	2	2	4	0.7
200 nm mark C/N (dB)	37	39	33	41
120 nm mark C/N (dB)	29	33	26	0

In case of a conventional disk of Comparative example 2 that had no mask layers, a relatively high C/N value of 41 dB was obtained in a 200 nm mark. However, no signals were detected in a shorter 120 nm mark. A conventional disk of Comparative example 1 which had a silver oxide mask layer exhibited a very high reading power of 4 mW and a C/N value of 26 dB in a 120 nm mark. However, a C/N value at a 200 nm mark was 33 dB, which was remarkably lower than that of Comparative example 2. This is because such a high reading power causes to erasure of data in a recording layer. In case of optical disks of Examples 1 and 2, a reading power was 2 mW, which was higher than that of Comparative example 2 but was one-half lower than that of Comparative example 1. In addition, optical disks of Examples 1 and 2 exhibited 29 and 33 dB signals, respectively, at a 120 nm mark, each of which is higher than that of comparative example 1.

[Effect of the Invention]

As apparent from the above description, the present invention provides an optical disk with large storage capacity and high density of recorded data. Accordingly, there is not necessary to decrease the wavelength of a laser diode or increase the numerical aperture in an objective lens. In addition, because a source of the surface plasmon is fine metal particles such as silver particles, not silver oxide, a reading power is decreased. For this reason, the recording state of a recording layer is stable. Furthermore, because dissociation and association of silver oxide are not involved, although a recording and reading procedure is repeated, stability of the optical disk is secured.

What is claimed is:

1. A high density optical disk, readable only or recordable and readable, comprising:

a plastic substrate;

one or more mask layers with a super resolution near field structure, which are made of a mixture of a dielectric material and metal particles; and

a reflective layer, and

wherein when the optical disk is used as a readable only disk, a pit pattern is formed on the substrate, and when the optical disk is used as a recordable and readable disk, the optical disk further comprises a recording layer.

2. The optical disk according to claim 1, wherein the dielectric material is metal oxide, nitride, sulfide, fluoride or a mixture thereof.

3. The optical disk according to claim 2, wherein the dielectric material is $ZnS-SiO_2$.

4. The optical disk according to claim 1, wherein the metal particles are derived from gold, silver, platinum, rodium, palladium or a mixture thereof.

5. The optical disk according to claim 4, wherein the metal particles are silver particles.

6. The optical disk according to claim 1, further comprising dielectric layers at the upper and the lower surfaces of the mask layer.

FIG 1

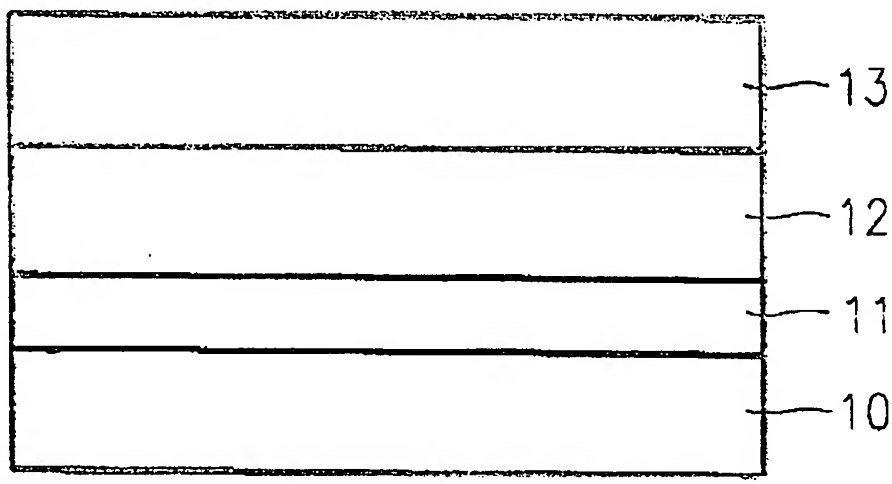

FIG. 2

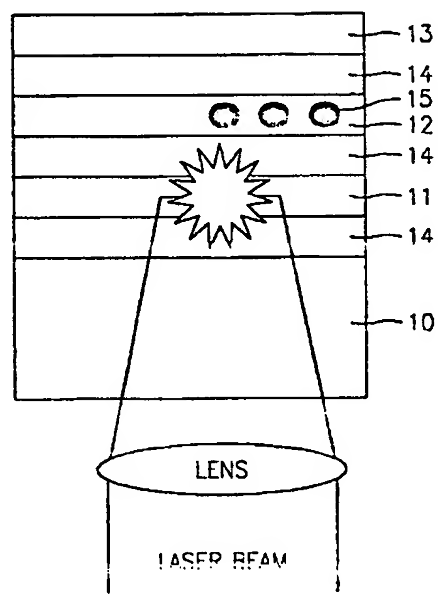

FIG. 3